

A REVISION OF THE BRITISH ALEYRODIDAE
(HEMIPTERA : HOMOPTERA)

BY

L. A. MOUND *vw*

Dept. of Entomology, British Museum (Nat. Hist.)

Pp. 397-428 ; 29 *Text-figures*

BULLETIN OF
THE BRITISH MUSEUM (NATURAL HISTORY)
ENTOMOLOGY

Vol. 17 No. 9

LONDON : 1966

THE BULLETIN OF THE BRITISH MUSEUM (NATURAL HISTORY), instituted in 1949, is issued in five series corresponding to the Departments of the Museum, and an Historical series.

Parts will appear at irregular intervals as they become ready. Volumes will contain about three or four hundred pages, and will not necessarily be completed within one calendar year.

In 1965 a separate supplementary series of longer papers was instituted, numbered serially for each Department.

This paper is Vol. 17, No. 9 of the Entomological series. The abbreviated titles of periodicals cited follow those of the World List of Scientific Periodicals.

© Trustees of the British Museum (Natural History) 1966

TRUSTEES OF
THE BRITISH MUSEUM (NATURAL HISTORY)

Issued 4 January, 1966

Price Fourteen Shillings

A REVISION OF THE BRITISH ALEYRODIDAE (HEMIPTERA : HOMOPTERA)

By L. A. MOUND

	CONTENTS	Page
INTRODUCTION		399
LIST OF SPECIES RECORDED FROM BRITAIN		401
PREPARATION OF MATERIAL FOR MICROSCOPICAL STUDY		402
KEY TO GENERA		402
SYSTEMATIC LIST OF GENERA OF HOST PLANTS		424
REFERENCES		425
INDEX TO GENERA AND SPECIES		427

SYNOPSIS

At present it is rarely possible to recognize species of whitefly when the only instar available for study is the adult. The generic classification is based on the morphology of the pupal cases, and species can be accurately defined on this instar if allowance is made for the occurrence of host-correlated variation in certain structures. Fifteen species are known in this country from their pupal cases, and these are figured and redescribed, and a key for their determination has been constructed. The record of a further species is not accepted as it is based only upon observations on adults. Three new synonymies and one new combination are given.

INTRODUCTION

THE insects belonging to the family Aleyrodidae have been neglected to a remarkable extent by British entomologists. Nineteen species are listed in the 1964 edition of Kloet & Hincks, but in the following revision more than half of those entries have to be deleted or altered in some way. Fifteen species placed in twelve genera are here considered to be validly recorded from this country, and there is one further species of which the record is regarded as doubtful.

The taxonomy of the Aleyrodidae is unusual in that species are more readily defined on characters of the "pupal case", the exuvium of the fourth instar larva, than on the winged adults. It is barely possible to recognize even the British species of adult whitefly, and moreover it is not possible at present to associate the adults into genera. The basis of the generic classification was laid by Quaintance & Baker (1913 and 1914) using the pupal cases, and in view of the fact that this is the stage most frequently collected, most authors have adopted this system. Host plant records based on pupal cases are clearly of greater biological significance than records based on adults, which may alight fortuitously upon almost any plant. The difficulties encountered with the present classification are probably the result of more work on the group having been carried out in temperate regions, whereas most species occur in the tropics.

In recent years the accuracy with which species can be defined has been greatly increased. Russell (1948) has demonstrated that there are numerous characters to be observed on the pupal cases, although accurate observation of small pores and setae less than 3μ in length necessitates the use of an oil-immersion objective as well as very careful preparation of the specimens. In the following pages, references to

recent descriptions or descriptive details are given of all the species recorded from Britain, since several of these have never been described adequately. Earlier workers failed to define the species to which they were referring, and it was common practice to apply as specific epithet to a whitefly, the name of the host plant on which it was found, without attempting to recognize the species morphologically. Thus Trehan (1940) refers to a whitefly from *Corylus avellana* as *A. avellanae* Signoret, despite the fact that Signoret described his species as having spotted wings and Trehan's specimens had immaculate wings. In the same paper, Trehan refers to a species from *Carpinus* as *A. carpinii* Koch, although the description of the latter is so vague that the name cannot be applied with accuracy to any species. For similar reasons, the records of *aceris* Geoffroy and *vaccinii* Künow from the North of England (Harrison, 1920) are not accepted here. Records are only acceptable if they are based on a microscopical examination of the pupal case and, where possible, comparison should be made with "type specimens" or other accurately determined material. Unless stated otherwise, material used in the following studies is deposited in the British Museum (Natural History).

One of the most interesting, and for the taxonomist, most disconcerting, aspects of the Aleyrodidae is the remarkable range of variation in appearance of the pupal cases of certain species. Moreover, this variation is to a large extent related to the type of leaf surface upon which the insect has developed. On a hairy leaf, pupal cases are usually small, with a deeply crenulate, often indented, margin and elongate dorsal setae. The same species on a smooth leaf may have a large pupal case with a smooth border and few or no elongate dorsal setae (Russell, 1948 on *Trialeurodes*; Mound, 1963 on *Bemisia*). The present author has recently examined a specimen of *Bemisia tabaci* from a grass leaf. This pupal case was very elongate, similar in shape to certain other grass living species, e.g. *Aleurocybotus*, and quite different in shape from typical *B. tabaci* on one of its many dicotyledonous hosts. This type of variation is very confusing and has given rise to numerous synonyms in certain species (Russell, 1958).

An interesting ecological problem is the remarkable persistence of individual populations of whitefly. Thus *T. ericae* has been known at Camberley, Surrey, on *Erica tetralix* for over thirty-five years. The populations of *S. phillyreae* and *P. azaleae* at Wisley must be of similar long standing, each on the same group of shrubs, throughout that period. The same appears to be true of the Ivy Whitefly, *S. immaculata*, for which the present author has frequently searched. Although this insect is quite widespread and the number of individuals at any one site may be large, populations are only rarely encountered. The existence of such long lived populations could be of considerable interest to the ecologist who wishes to study the interaction of predators and parasites with climate upon an insect population (Mound, 1965a).

The three species marked in the following list as having been found only in greenhouses in this country may not survive for long, as a result of improvements in chemical control of insects. However, the Greenhouse Whitefly *T. vaporariorum* is still all too common and is the most important pest in this family in Europe. *A. jelinekii*, *D. chittendeni* and *P. azaleae* may occasionally develop sufficiently large

populations to be regarded as minor pests, whereas in tropical countries whitefly are important on a number of crops, e.g. Citrus (*Aleurocanthus woglumi*, *Dialeurodes citri*, *Aleurothrixus floccosus*), sugar cane (*Aleurolobus barodensis*, *Neomaskellia bergii*), coconut and cashew (*Aleurodicus cocois*). On cotton, tobacco and cassava, *Bemisia tabaci* is a pest both in its own right (Mound, 1965c) and as a virus vector (Tarr, 1951; Beck & Chant, 1958).

The list of host plants (page 424) was arranged systematically under families at the suggestion of Dr. V. F. Eastop, for whose frequent advice the author is very grateful. This systematic arrangement of plants draws attention to the different types of host association which can be found amongst the Aleyrodidae. Two species are almost certainly monophagous, *S. immaculata* on *Hedera*, and *T. ericae* on *Erica*. At the other extreme are *A. fragariae*, polyphagous on many herbs and under shrubs in Europe, and *B. tabaci* and *T. vaporariorum*, which have been found in various parts of the world on numerous plants, both monocotyledons and dicotyledons. Some whitefly have a host range which is basically limited to plants of known botanical affinity, such as *P. quercus* on Corylaceae and Fagaceae. But in other species the host range is not associated with botanical relationship, e.g. *A. jelinekii* on *Viburnum* and *Arbutus*. These two plants belong to widely different families, but it may be noted that they both have hard evergreen leaves. A similar relationship exists between the host plants of *A. proletella*, but in this case the leaves are soft and smooth. *A. fragariae*, it should be noted, has been found on both smooth and hairy leaves.

The author is pleased to acknowledge the help and advice of Mr. F. Laing, by whom the whitefly collection at the BM (NH) was developed and arranged.

LIST OF SPECIES RECORDED FROM BRITAIN

- Aleyrodes proletella* (Linnaeus, 1758)
- Aleyrodes fragariae* Walker, 1852
- ?? *Aleurochiton complanatus* (Baerensprung, 1849)
- † *Aleuropteridis filicicola* (Newstead, 1911)
- Aleurotrachelus jelinekii* (von Frauenfeld, 1867)
- † *Aleurotulus nephrolepidis* (Quaintance, 1900)
- Asterobemisia avellanae* (Signoret, 1868)
- * *Bemisia tabaci* (Gennadius, 1889)
- Dialeurodes chittendeni* Laing, 1928
- † *Filicaleyrodes williamsi* (Trehan, 1938)
- Pealius azaleae* (Baker & Moles, 1920)
- Pealius quercus* (Signoret, 1868)
- Siphoninus phillyreae* (Haliday, 1834)
- Siphoninus immaculata* (Heeger, 1855)
- Tetralicia ericae* Harrison, 1917
- Trialeurodes vaporariorum* (Westwood, 1856)

?? Doubtful record, apparently refers only to adults.

* Status of species doubtful.

† Only in glasshouses in this country.

PREPARATION OF MATERIAL FOR MICROSCOPICAL STUDY

The best mounts are obtained from pupal cases from which adults have emerged. It should be noted that the presence of a parasite often results in morphological changes in a whitefly pupal case and such specimens are best avoided. Pupal cases are picked from leaves with needles, placed in 10% sodium hydroxide, and heated gently for up to ten minutes depending on the age and size of the specimens. At the end of this period, cold glacial acetic acid is poured into the hydroxide causing the pupal cases to float and usually removing the cuticular wax. It is essential that this wax be removed before staining, and prolonged treatment with hydroxide should be avoided or much of the cuticular detail will be lost. Wash the specimens in glacial acetic acid and then stain with acid fuchsin for up to ten minutes. Black pupal cases need not be stained but should be bleached in Diaphanol or chlorine vapour. The stained material may be dehydrated in a mixture of equal parts of glacial acetic acid and cellosolve, then cleared in carbol-xylol, and finally xylol before mounting in Canada balsam. It is best to mount some specimens dorsal side and others ventral side up, although with certain species the dorsum can be removed from the ventral surface and the two mounted side by side.

KEY TO GENERA

- 1 Median length of abdominal segment seven less than half that of segment six (Text-figs. 7 and 12) 2
- Median length of abdominal segment seven more than half that of segment six, these two segments often about equal in length (Text-figs. 1 and 9) 7
- 2 Expanded lingula tip at least twice as long as broad, elongate spatulate or conical in shape, vasiform orifice elongate triangular; abdominal segments four to eight each with one pair of subdorsal setae 3
- Expanded lingula tip distinctly knobbed, never twice as long as broad 4
- 3 Caudal furrow present; transverse moulting suture extends laterally
BEMISIA (p. 413)
- Caudal furrow not developed; transverse suture extends laterally then curves to anterior meeting in mid-line of cephalic region *ASTEROBEMISIA* (p. 411)
- 4 Submarginal papillae present; marginal crenulations weak and irregular; lingula tip with three paired lateral, and one distal, lobes 5
- Submarginal papillae absent; marginal crenulations well developed and regular 6
- 5 Submarginal papillae conical; tracheal pore areas not well defined
TRIALEURODES (p. 422)
- Submarginal papillae broad and shallow; tracheal pore areas well defined
FILICALEYRODES (p. 416)
- 6 Lingula tip small, D-shaped, with two basal lobes; floor of vasiform orifice with many ridges *PEALIUS* (p. 418)
- Lingula tip large, circular, extending beyond hind margin of orifice (in poor preparations, apparently D-shaped and included within orifice) *ALEUROTULUS* (p. 410)
- 7 Pupal case with black cuticle 8
- Cuticle of pupal case white, colourless, or light brown 9
- 8 Dorsal disc recurved ventrally, without dorsal wax *TETRALICIA* (p. 420)
- Dorsal disc not recurved ventrally, keeled in mid-line, dorsum with much wax
"ALEUROTACHELUS" (p. 410)
- 9 Dorsum with numerous tubes, each about 100 μ long *SIPHONINUS* (p. 419)

- Dorsum never with tubes, with or without long setae 10
- 10 Dorsal disc recurved ventrally around margin, looking like a submarginal fold or suture **ALEUROPTERIDIS** (p. 408)
- Dorsal disc not recurved ventrally 11
- 11 Operculum almost covers lingula; small paired setae close to caudal furrow just behind orifice; dorsal disc with numerous small tubercles **"DIALEURODES"** (p. 414)
- Operculum not covering lingula tip; without setae close to furrow behind orifice 12
- 12 Vasiform orifice subcordate; lingula tip expanded, spatulate; pupal case pale **ALEYRODES** (p. 403)
- Vasiform orifice widely open at posterior; lingula tip scarcely expanded; pupal case light brown with darker markings **ALEUROCHITON** (p. 407)

Family **ALEYRODIDAE** Westwood, 1840

Subfamily **ALEYRODINAE**

All the species recorded from this country belong to one subfamily. The species of the other subfamily, the Aleurodicinae Qu. & B., 1913, are mainly described from South America.

ALEYRODES Latreille, 1796

Type-species, *Phalaena (Tinea) proletella* Linnaeus, 1758.

This, the first whitefly genus to be named, was defined by Latreille and placed as the sole genus in a new, but unnamed, family in 1796 (p. 93). No species were included at this date but the publication is valid, as in 1801-2 (p. 264) Latreille redefined the genus and added "Exemples, *Tinea proletella* Lin. (Et quelques pucerons)". It should be noted that he had first indicated the hemipterous nature of *proletella* in 1795 (p. 304).

Linnaeus first published the name *proletella* under *Phalaena (Tinea)* in 1758, *Systema Naturae*, ed. 10 : 537, no. 261, but his description "alis albidis punctis duobus fuscis, lingua inflexa" was followed by a "dagger mark" †. This mark is interpreted by Stearn (1957 : 162) as indicating either that Linnaeus had not seen the species or that there was some doubt about it. In the Twelfth Edition, the same entry is given, but under number 379. However in the revision by Gmelin (1790 : 2594), the Thirteenth Edition, the entry is followed by the words "an hujus familiae?". It seems likely that Linnaeus never observed the species himself, particularly as neither first nor second edition of *Fauna Suecica* (1746 and 1761) contain any reference to it.

The identity of the insect species referred to by Linnaeus under the name *proletella* is clarified from a study of the rest of the entry which follows his description quoted above, "Vallism. nat. 1. p. 372. t. 379; Reaum. ins. 2. t. 25; Habitat in Brassica, Chelidonio; an etiam in Quercu? Parit quotannis ad 200000 soboles; dum 12 progenies ponant 12 ova singulae." Réaumur (1736 : 302-317, plate 25) gives a good account of the life history of the insect on "L'éclair" (Greater Celandine, *Chelidonium major*) and also gives reasons for considering this as the same species as that found on cabbage. Seventeen figures are included and the structure of the

rostrum is contrasted with the coiled mouth-parts of other "phalènes". The author goes so far as to suggest that this insect might be placed in a new class of moths on account of this character as well as the waxy nature of the powder covering the wings. The reference to Vallisneri (1733 : 372-378), which is also given by Réaumur, is to a long letter from Cestoni giving an account of the behaviour of the cabbage whitefly. The emergence of the winged adult from the sessile larva is described, and this article goes on to state that the insect is not only found on cabbage, but also on oak, various grasses, and other plants both "comestibili e non comestibili". From this it is almost certain that Cestoni was concerned with more than one species. However, as Linnaeus gives only *Brassica* and *Chelidonium* as definite hosts for his species, this is an indication that *proletella* refers to the common European Cabbage Whitefly, as discussed and figured by Réaumur from *Chelidonium*.

Only two valid species of the genus *Aleyrodes* are recorded from the British Isles, and the pupal cases of these may be separated by the use of the following key :

- Vasiform orifice smoothly rounded at posterior, lateral margins without tooth-like ridges; abdomen without median tubercles but with transverse rows of minute microtrichia; caudal setae usually extend little beyond body margin; three pairs of major dorsal setae equal in length to caudal setae . . . *A. proletella* (p. 404)
- Vasiform orifice sharply transverse at posterior, with terminal triangular lobe, lateral margins with tooth-like ridges; abdomen usually with median tubercles; caudal setae extend well beyond body margin usually; often more than three pairs of major dorsal setae, up to six pairs, equal in length to caudal setae . . . *A. fragariae* (p. 406)

Aleyrodes proletella (Linnaeus)

(Text-figs. 1-3)

Phalaena (*Tinea*) *proletella* Linnaeus, 1758.

Phalaena culiciformis Geoffroy in Fourcroy, 1785 : 306.

Aleyrodes proletella (L.) Latreille, 1801-2.

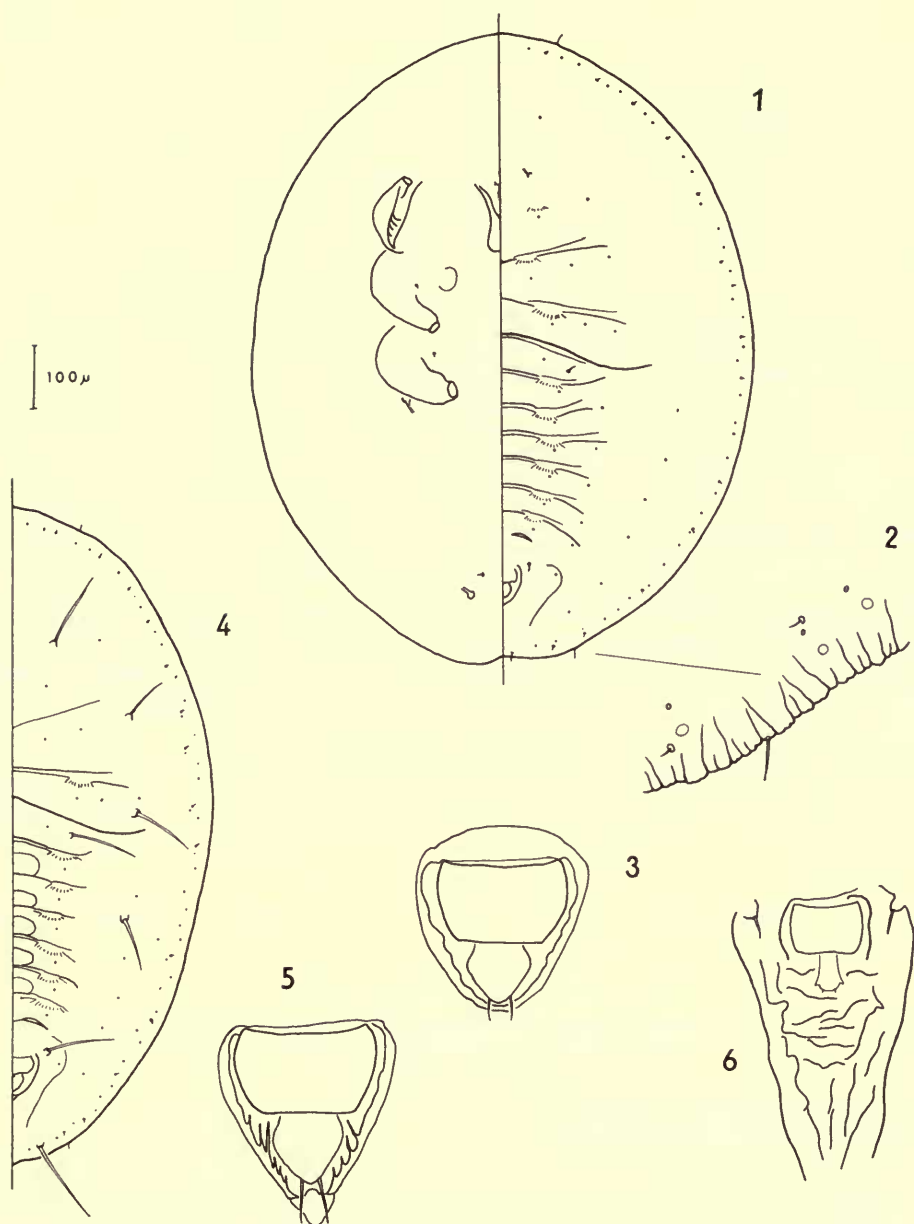
Aleyrodes chelidonii Latreille, 1807.

Aleyrodes brassicae Walker, 1852.

The specific epithets *culiciformis* and *chelidonii* were both proposed as new names for the whitefly of *Chelidonium major*. *A. brassicae* was stated by Walker in his description to be "possibly a variety of" the *Chelidonium* Whitefly, and Haupt (1935) and Trehan (1940) have both indicated that *brassicae* is a synonym of *proletella*.

A. proletella is common throughout England and occasionally is a pest on cabbages and Brussels sprouts. It occurs throughout the year and it is not unusual to find adults in January moving freely on leaves bearing snow and frost. The geographical distribution of the species has yet to be discovered but the present author has examined material from Nairobi, Kenya, on *Sonchus*, from an unknown host at Bahia, Brazil, and from *Vicia* and *Cichorium* at Alexandria, U.A.R.

Pupal case. Usually on lower surface of leaves, White, occasionally with faint pigmentation laterally on cephalo-thorax, sometimes yellowish particularly when parasitized. Living fourth instar often yellow/green due to body contents, or apparently black when containing parasite pupal case. Rarely with marginal wax. Length 1.3-1.5 mm. Breadth 0.8-0.9 mm.



FIGS. 1-6. 1. *Aleyrodes prolella*, dorsal and ventral surfaces. 2. *A. prolella*, posterior margin. 3. *A. prolella*, vasiform orifice. 4. *Aleyrodes fragariae*, dorsal surface. 5. *A. fragariae*, vasiform orifice. 6. *Aleurochiton complanatus*, vasiform orifice.

Margin. Smoothly crenulate, 8–10 crenulations in 50 μ . Weak ridges, about 30 μ long, run medially from crenulations. If margin is not quite flat, these ridges appear like stout crenulations. Anterior and posterior marginal setae present, 10–15 μ long. Caudal setae submarginal in origin, about 15 μ long, arising 10 μ within margin. Tracheal pore areas not differentiated.

Dorsal surface. Three pairs of major setae, 10–15 μ long, on cephalic region, and first and eighth abdominal segments. Eighth abdominal setae lateral to anterior margin of operculum, about 15 μ from orifice. Fourteen pairs of minor dorsal setae, 3 μ in length or shorter, about 25 μ from margin. These setae arranged as follows; cephalic region four pairs, prothorax one pair, mesothorax two pairs, metathorax one pair, first abdominal segment one pair, abdominal segments four to eight each with one pair. These setae most obvious on posterior abdominal segments, often concealed by rolling of margin or submarginal ridges. Transverse moulting suture short, reaches external margin of legs, barely turns to anterior, pupal case often torn in this region. Thoracico-abdominal suture visible medially just posterior to transverse moulting suture. Abdominal rhachis weakly defined, with transverse rows of finest microtrichia. Abdominal sutures extend to subdorsum, sutures one to seven with paired submedian depressions. First and second abdominal sutures bend to anterior. Segments one to six, and eight subequal in length, seven shorter, about three-quarters of six in mid-line. Abdomen with four paired rows of pores; submedian, posterior to submedian depressions; latero-median, near lateral extremities of segmental sutures; subdorsal; and submarginal, close to minor setae. Latero-median and subdorsal pores absent on segment two. Each pore is accompanied by a circular area which fails to stain as deeply as the surrounding cuticle. These structures (pseudopores) lie close to the pores on the rhachis, but in the submarginal row the pseudopores are much closer to the margin than the pores. Pores and pseudopores irregular in number in submarginal row. Vasiform orifice slightly wider than long, length 65 μ , breadth 75 μ approximately. Lateral margins not toothed, internal surface lightly sculptured, posterior margin entire. Operculum transversely rectangular, occupies less than half of orifice, about 30 μ long. Lingula exposed but included within orifice, lingula tip usually as broad as long, sometimes rather longer than broad, paired terminal setae extend beyond orifice margin. Caudal ridges very weakly defined.

Ventral surface. Meso- and metathoracic legs each with a minute (2 μ) seta basally. One pair of small setae just anterior to rostrum, 5 μ long and about 5 μ apart. Ventral abdominal setae antero-medial of posterior spiracles, 15 μ long and about 50 μ apart. Anterior abdominal spiracles larger than posterior spiracles, tracheal folds not differentiated. Antennae extend to base of first leg.

Host plants : *Brassica* spp., *Chelidonium major*, *Sonchus* sp., *Vicia faba*, *Cichorium* sp.

Aleyrodes fragariae Walker, 1852

(Text-figs. 4–5)

Aleyrodes lonicerae Walker, 1852, **syn. n.**

Aleurodes spiraeae Douglas, 1894, **syn. n.**

Zahradnick (1963), as well as several other authors, gives *A. fragariae* as a synonym of *A. lonicerae*. However *A. fragariae* appears as the third species of *Aleyrodes* in Walker's List of Homoptera, and *A. lonicerae* as the fourth. The descriptive details of *A. fragariae* are given in the list in the definition of the second species, *A. brassicae*. Thus *fragariae* must be regarded as the first available name. *A. spiraeae* was described by Douglas from several adults and a single pupal case on the leaves of

Meadow-Sweet (*Filipendula Ulmaria*). This pupal case has now been stained and mounted in Canada balsam at the British Museum (Natural History) and is recognizable as a parasitized specimen of *A. fragariae*.

The Strawberry Whitefly is polyphagous, and is common throughout Britain. Adults and larvae may be found all through the year, but the species seems to be particularly common in years with a hot dry summer. The variation in number of the long dorsal setae of the pupal case is referred to by Trehan (1940).

Pupal case. Very similar to *proletella*, sometimes with a more distinct waxy fringe on hairy leaves.

Margin. As in *proletella* but caudal setae more than 80 μ long.

Dorsal surface. Major setae very variable in number and size, rarely small, usually 50 μ to 100 μ long. Paired major setae on cephalic region, and first and eighth abdominal segments; also frequently developed in subdorsal region on meso- and metathorax, and fourth abdominal segment, i.e. six pairs of major dorsal setae. Submarginal setae as in *proletella*. Rhachis quite well defined, with rounded median tubercles. Abdominal segments subequal in length, segment seven not so distinctly shorter than six and eight as in *proletella*. Vasiform orifice as long as, or longer than wide, length 75 μ , breadth 70 μ approximately. Lateral margins with tooth-like ridges, inner surface lightly sculptured, posterior margin transverse with an additional posterior triangular lobe. Operculum and lingula as in *proletella*. Caudal ridges moderately developed.

Ventral surface. As in *proletella* except caudal tracheal fold indicated by minute raised dots.

Host plants. *Fragaria vesca*, *Geum arvense*, *Rubus fruticosus*, *Filipendula Ulmaria* (Rosaceae); *Lonicera periclymenum*, *Symphoricarpos racemosus* (Caprifoliaceae); *Nepeta glechoma*, *Teucrium scorodonium* (Labiatae); *Melampyrum pratense* (Scrophulariaceae); *Thalictrum babingtonii* (Ranunculaceae); *Hypericum andraesemum* (Hypericaceae); *Campanula trachelium* (Campanulaceae); *Cardamine amara* (Cruciferae); *Chamaenerion angustifolium* (Onagraceae); *Aegopodium podagraria* (Umbelliferae).

ALEUROCHITON Tullgren, 1907

Type-species, *Chermes aceris ovatus* Geoffroy, 1762, a synonym of *Aleyrodes complanatus* (Baerensprung, 1849), after Schumacher, 1918.

The trinomial *Chermes aceris ovatus* as used originally by Geoffroy in 1762 has to be rejected according to the Rules of International Zoological Nomenclature. The binomial *Chermes aceris* used by Geoffroy in 1785 must also be rejected as a homonym of *Chermes aceris* Linnaeus, 1758. According to Schumacher (1918) the next available name for this insect is *Lecanium complanatum* Baerensprung, 1849. There are two species belonging to this genus in Central Europe, *A. complanatus* and *A. acerina* Haupt, on *Acer platanoides* and *campestre* respectively. A related species *Neoaleurochiton pseudoplatani* Visnya is found in Central Europe on *Acer pseudo-platanus*.

***Aleurochiton complanatus* (Baerensprung)**

(Text-fig. 6)

Chermes aceris ovatus Geoffroy, 1762.*Chermes aceris* Geoffroy, 1785 nec Linnaeus, 1758.*Lecanium complanatum* Baerensprung, 1849.*Aleyrodes acerum* Kirkaldy, 1907.*Aleurochiton aceris* (Geoffroy) Tullgren, 1907.*Aleurochiton complanatus* (Baerensprung) Schumacher, 1918.

This species was recorded from the North of England by Harrison (1920), apparently as a result of observing adult whitefly on the leaves of *Acer pseudoplatanus*. No reference was made to the presence of pupal cases, and in view of the large size and striking appearance of the immature instars with their white dorsal wax, it can only be assumed that Harrison did not observe any. In view of the fact that certain species of adult whitefly will settle on almost any plant when they are sufficiently numerous, it seems better at the moment to consider the presence of *A. complanatus* in this country as unproven.

***ALEUROPTERIDIS* Mound, 1961**

Type-species, *Aleuropteridis douglasi* Mound, 1961, a synonym of *Aleyrodes filicicola* Newstead, 1911, after Mound, 1965*b*.

This genus was defined for four new species, all of which had been found on ferns. The dorsal disc is reflexed ventrally around the margin, as in *Tetralicia* and *Aleuropleurocelus*, but less deeply and more evenly than in those two genera.

***Aleuropteridis filicicola* (Newstead)**

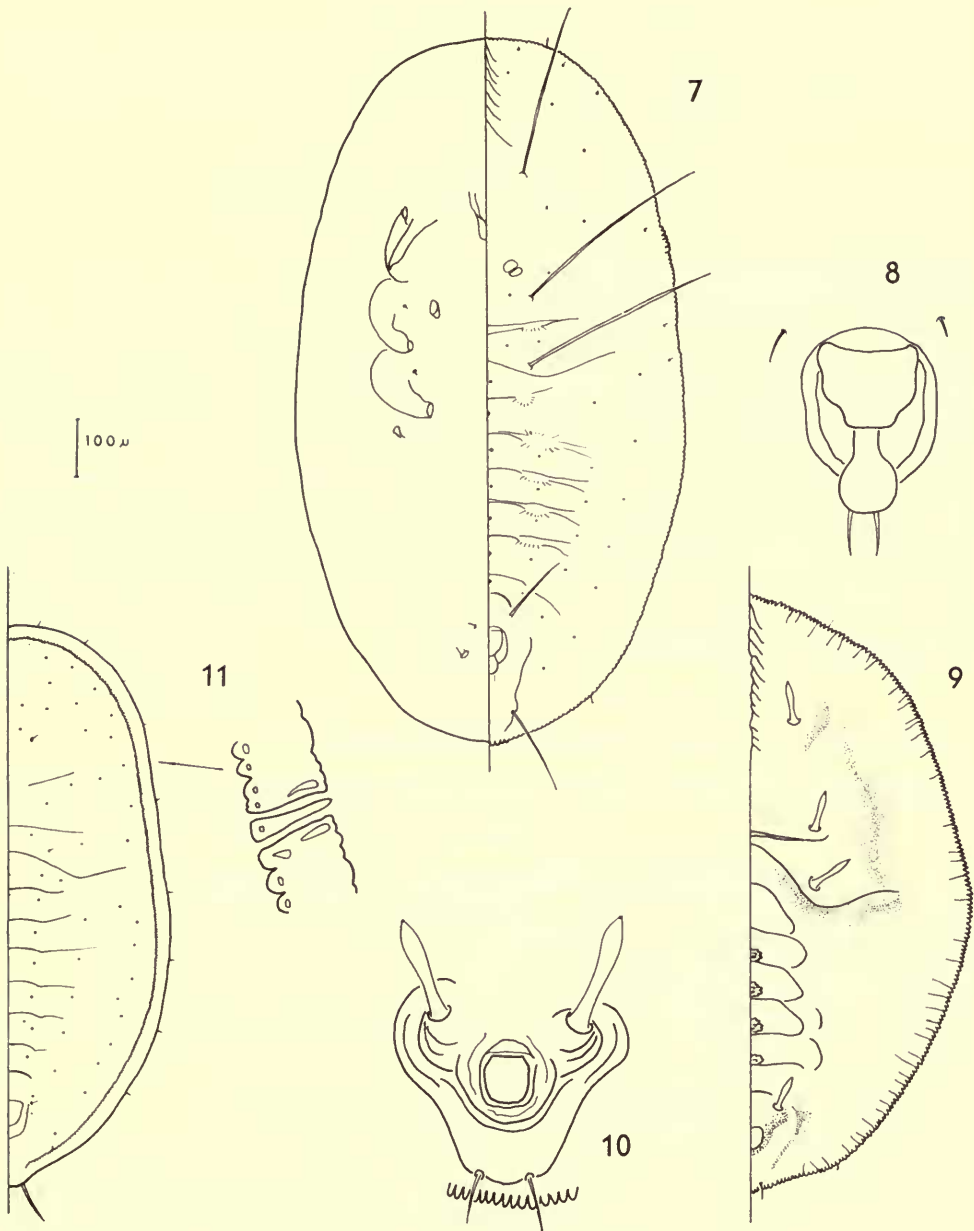
(Text-fig. 11)

Aleyrodes filicicola Newstead, 1911.*Aleuropteridis douglasi* Mound, 1961.*Aleuropteridis filicicola* (Newstead) Mound, 1965*b* : 135.

Described originally from Tanganyika, this species was redescribed under the name *douglasi* from material collected by J. W. Douglas on ferns in Kew Gardens. The leaves of the ferns were deposited in the British Museum (Natural History). This is the species referred to by Trehan (1938) as "*Aleyrodes filicium*" when distinguishing a new species *Aleuroplatus kewensis* = *Aleurotulus nephrolepidis*.

Pupal case. Pale with median longitudinal brown band. Margin with vertical wax palisade. Elongate ovate, narrowed to posterior. Length 0.8 mm. Breadth 0.4 mm. Small paired setae on cephalic, metathoracic and eighth abdominal segments. Caudal setae longer than orifice. True margin reflexed ventrally, apparent margin with nine pairs of small setae. Tracheal pore areas defined by about three enlarged teeth. Operculum three-quarters fills subrectangular orifice, concealing lingula.

Host plants. *Pteris togoensis*, *Cyclosorus dentatus*, *Oleandra articulata*.



FIGS. 7-11. 7. *Aleurotulus filicium*, dorsal and ventral surfaces. 8. *A. filicium*, vasiform orifice. 9. *Aleurotrachelus jelinekii*, dorsal surface. 10. *A. jelinekii*, vasiform orifice and hind margin. 11. *Aleuropteridis filicicola*, dorsal surface and detail of thoracic tracheal pore.

ALEUOTRACHELUS Quaintance & Baker, 1914

Type-species, *Aleyrodes tracheifer* Quaintance, 1900.

The species referred to below is not congeneric with *A. tracheifer*, but as this is true of a number of species at present included in that genus, it seems best to leave it until such time as a generic revision can be attempted.

Aleurotrachelus jelinekii (von Frauenfeld)

(Text-figs. 9-10)

Aleurodes jelinekii von Frauenfeld, 1867.

Aleyrodes (*Frauenfeldiella*) *jelinekii* (Frauen.) Gomez Menor, 1943.

Aleurotrachelus jelinekii (Frauen.) Fowler, 1954.

Although apparently an introduced species, this insect is widespread in Southern England, and occasionally so abundant as to be a pest on its host plant, the ornamental shrub *Viburnum tinus*. As an account of the species has been published recently (Mound, 1962) a full description is not included here.

Pupal case. Black, with dorsal rolls of flocculent white wax, and white waxy marginal fringe. Length 1.1 mm. Breadth 0.8 mm. Oval, barely constricted at thoracic tracheal pores, dorsum elevated in mid-line. Paired stout setae, apparently secretory, on cephalic region, meso- and metathorax, and eighth abdominal segment. Cephalothorax with a longitudinal ridge on each side in subdorsum. Vasiform orifice elongate rectangular, filled by operculum, which conceals lingua.

Host plants. *Viburnum tinus*, *Arbutus unedo*.

ALEUOTULUS Quaintance & Baker, 1914

Type-species, *Aleurodes nephrolepidis* Quaintance, 1900.

This is a very poorly known genus, in which are included, apart from the type-species, four species known only from their original descriptions.

Aleurotulus nephrolepidis (Quaintance, 1900)

(Text-figs. 7 and 8)

Aleurodes filicium Douglas, 1891a nec Goeldi, 1886.

Aleuroplatus kewensis Trehan, 1938. **syn. n.**

In 1886 Goeldi described a whitefly, *A. filicium*, from ferns in Brazil. The description of this insect includes the statement (in italics) that there are five pairs of very long setae on the ventral surface (Bauchseite) for attachment to the substrate (zum Anhaften auf der Unterlage.) *A. nephrolepidis* differs from the description of *A. filicium* in having five pairs of setae on the dorsal surface, a fairly common condition in the Aleyrodidae. The arrangement of setae described by Goeldi is so remarkable that one is tempted to conclude that he had made an extraordinary mistake. In view of this, the best course of action is to regard *filicium* as a nomen dubium. The species of *Aleurotulus* on ferns in England is *A. nephrolepidis*, and the present author, after examining the type specimens of *A. nephrolepidis*, by the courtesy of the United States National Museum, and *A. kewensis*, at the British Museum (Natural

History) considers them to be the same species. In view of the fact that this whitefly has been recorded from both America and Europe on ferns in greenhouses, the following record is of considerable interest: Madagascar, on *Oleandra articulata*, in Buckton Collection at British Museum (Natural History), date uncertain, but before 1911.

Pupal case. White, elliptical in shape, with small marginal fringe of pale wax. Slightly elevated in mid-line. Length 0.8–1.0 mm. Breadth 0.5–0.65 mm.

Margin. Distinctly crenulate, about 12 crenulations in 100 μ . Tracheal pore areas indicated by slight expansion of four or five crenulations. Anterior and posterior marginal setae present.

Dorsal surface. Up to five pairs of long setae, including caudal setae. Caudal setae always long, about 125 μ , submarginal in origin, 40 μ within margin. Major dorsal setae short (5 μ), or long (up to 200 μ), on cephalic region, meso- and metathorax, and eighth abdominal segment. Eighth abdominal setae arise just anterior to orifice. Six pairs of minute submarginal setae (3 μ), three pairs in cephalic region, one pair on prothorax, one on metathorax, and one on first abdominal segment. Meso-metathoracic suture well developed. Transverse moulting suture reaches outer border of leg. Abdominal sutures weakly defined into subdorsum, seventh abdominal segment less than half length of six. Subdorsal region smooth or lightly sculptured. Dorsal pores in four paired rows on abdomen; submedian, posterior to submedian depressions; latero-median, near lateral extremities of abdominal sutures; subdorsal; and submarginal. Also an unpaired median row of segmental pores on rhachis. Vasiform orifice slightly longer than broad, 65 $\mu \times 50 \mu$, elevated slightly causing rounded posterior margin to appear thickened. Anterior rim distinct, 10 μ long. Lingula tip large, circular, with stout terminal setae, extending well beyond posterior margin of orifice. Lingula frequently retracts into orifice during mounting, tip then appears D-shaped. Operculum narrowed posteriorly, fills more than half of orifice.

Ventral surface. Anterior abdominal spiracle well developed. Thoracic tracheal folds barely indicated, caudal fold with numerous minute microtrichia. Ventral abdominal setae 20 μ long, 45 μ apart at base. Meso- and metathoracic legs each with one basal seta. Antenna not reaching base of first leg.

ASTEROBEMISIA Trehan, 1940

Type-species, *Aleurodes carpini* of Trehan nec Koch, 1857, a synonym of *Aleyrodes avellanae* Signoret, 1868, after Zahradnik, 1961.

The description of *A. carpini* Koch is an entirely inadequate account of an adult whitefly, and cannot be referred to any known species with accuracy. However the species that Trehan used when describing *Asterobemisia* can definitely be recognized as *A. avellanae*, because Signoret's collection of pupal cases still exists and has been examined by Zahradnik (1961). *Asterobemisia* is therefore regarded as a valid genus with *avellanae* Signoret as the type-species.

Asterobemisia avellanae (Signoret)

(Text-figs. 12–13)

Aleurodes avellanae Signoret, 1868.

Aleurodes ribium Douglas, 1888. [Syn. Ossiannilsson, 1955]

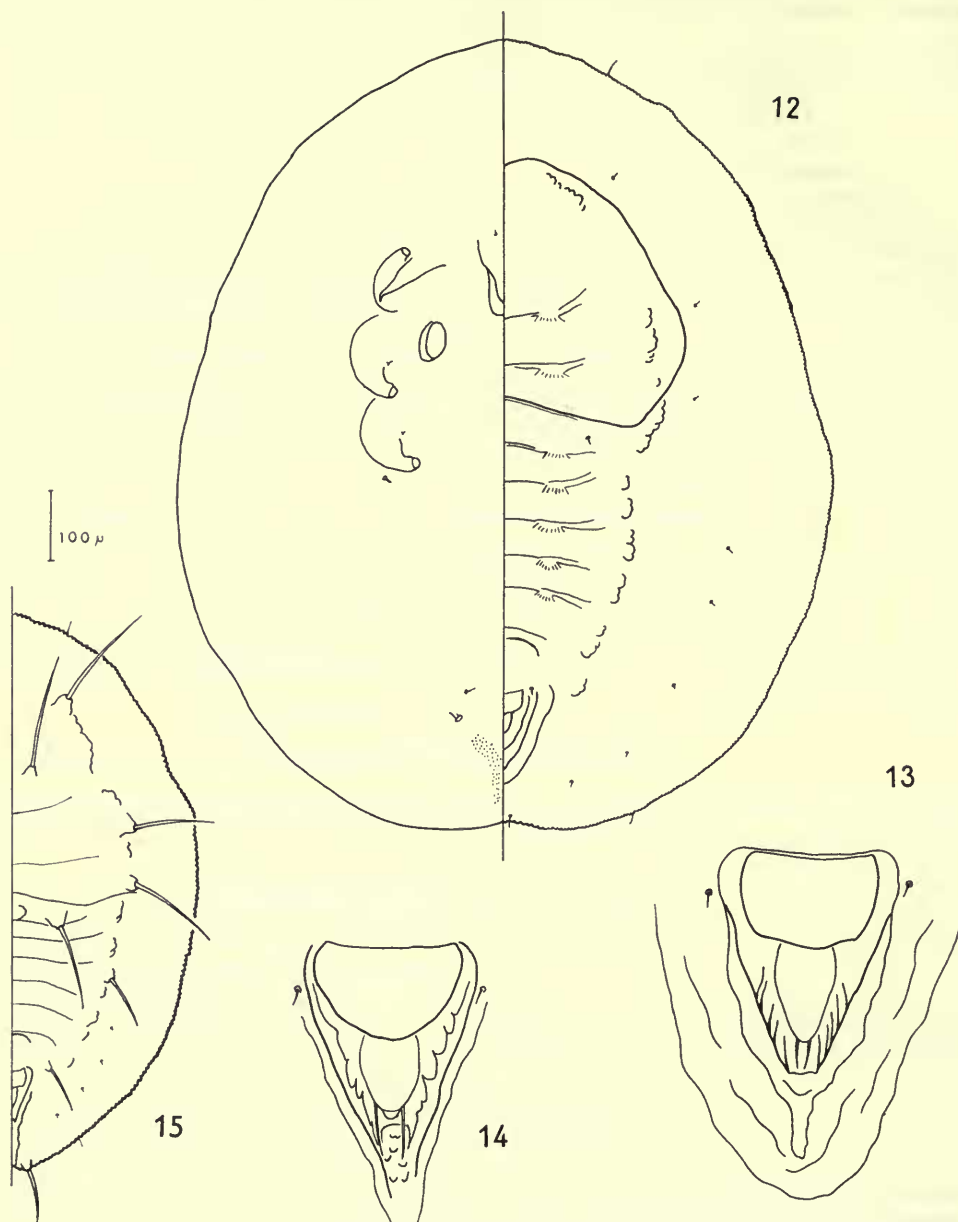
Aleurodes rubicola Douglas, 1891b. [Syn. Trehan, 1940]

? *Aleurodes vaccinii* Künow, 1880. [Syn. Zahradnik, 1963]

Asterochiton avellanae (Sign.) Harrison, 1920.

Asterobemisia carpini Trehan, 1940 nec Koch, 1857. [Syn. Zahradnik, 1961]

Asterobemisia avellanae (Sign.) Zahradnik, 1961.



FIGS. 12-15. 12. *Asterobemisia avellanae*, dorsal and ventral surfaces. 13. *A. avellanae*, vasiform orifice. 14. *Bemisia tabaci*, vasiform orifice. 15. *B. tabaci*, dorsal surface.

Both of the nominal species, *ribium* and *rubicola*, described by Douglas, are represented in the collection at the British Museum (Natural History) by the original author's material. Lectotypes are here designated from this material although both forms are identical with *A. avellanae*. *A. ribium* Douglas, lectotype pupal case, collected 23rd October, 1887, no locality given. *A. rubicola* Douglas, lectotype pupal case, collected 15th June, 1891, Bramble leaves, Blackheath Pits, 1244.

A. avellanae is apparently widespread in England, from Northumberland to the South Coast. A description has been published recently by Zahradnik (1961).

Pupal case. White, with little wax. Length 1.0–1.3 mm. Breadth 0.9–1.0 mm. Broadly oval, slightly emarginate at thoracic and posterior tracheal pores. Margin sometimes deeply indented due to proximity of leaf hairs during development. Caudal setae short, little longer than anterior and posterior marginal setae. Dorsal setae small to minute (5–15 μ), on cephalic region, and first and eighth abdominal segments, also subdorsally on abdominal segments four to eight. Transverse moulting suture bends to anterior and meets in mid-line. Seventh abdominal segment short, less than half length of sixth segment. Median area usually divided from subdorsum by row of tubercles. Vasiform orifice triangular, lingula spatulate, exposed, included. No caudal furrow, caudal ridges meet just behind orifice forming a triangular area. Thoracic tracheal folds not strongly marked, posterior fold indicated by rows of raised dots.

Host plants. *Corylus avellana*, *Carpinus betulus*, *Rubus* spp.

BEMISIA Quaintance & Baker, 1914

Type-species, *Aleurodes inconspicua* Quaintance, 1900, a synonym of *Aleurodes tabaci* Gennadius, 1889, after Russell, 1958.

Species included in this genus have an elongate triangular vasiform orifice, usually with an exposed triangular lingula tip. There is a series of subdorsal setae which are often overlooked when small, but are occasionally long and stout.

Bemisia tabaci (Gennadius, 1889)

(Text-figs. 14–15)

This species is remarkable for the extraordinary amount of variation which occurs in the pupal case. As a result, numerous synonyms exist (Russell, 1958), and several probably await detection. Thus *B. minima* and *B. miniscula*, described by Danzig (1964) from Russia, appear from their descriptions to fall within the known limits of variation of *B. tabaci*, and have yet to be shown to differ from this widespread polyphagous species. The variation in *tabaci* is related to the nature of the host plant leaf on which a pupal case develops. On hairy leaves, pupal cases are often small with long dorsal setae, whilst on glabrous leaves they are large with very small setae, and this variation has been demonstrated experimentally (Mound, 1963). Variants of this type have previously been regarded as host specific species, but host correlated variation is not uncommon throughout the Aleyrodidae (Mound, 1965*b*).

B. tabaci has only been found once in England, and the record has not been published hitherto. The species was collected by Dr. A. M. Massee on *Veronica* sp. at East Malling, Kent, in July 1943. As it was found in the middle of a wood over

quite a restricted area, Dr. Massee (in litt.) considered that it was unlikely to have been introduced from glasshouses. The species is widespread throughout the tropics and subtropics, and it is frequently a pest (Mound, 1965*a* and *c*). It is extremely polyphagous, and it would be very interesting to know if it can overwinter in this country. As a discussion of the variation of the pupal case was published recently (Mound, 1963), the species is only figured here without further descriptive details.

DIALEURODES Cockerell, 1902

Type-species, *Aleurodes citri* Ashmead, 1885.

When the species, which is discussed below, was described, Laing (1928) pointed out that "Though the species is not typically a *Dialeurodes*, it may conveniently rest in that genus until the classification of the family is better understood."

Dialeurodes chittendeni Laing, 1928

(Text-fig. 18)

Aleuroclava chittendeni (Laing) Takahashi, 1938.

The Rhododendron Whitefly was collected originally in this country near Ascot, where in 1928 it caused considerable damage to its host plant. It does not seem to be very common now, even in its type locality where rhododendrons are abundant. The species was referred to the genus *Aleuroclava* by Takahashi (1938), but it is not related to the four species at present included in that genus, none of which, it may be noted, are very closely related to each other. The generic affinities of *D. chittendeni* appear to lie with certain Indo-Malaysian species described in, but not belonging in, the genus *Triaeurodes*, e.g. *T. bicolor* Singh, and *T. malayensis* Corbett. The following redescription is based on the holotype and paratypes in the British Museum (Natural History).

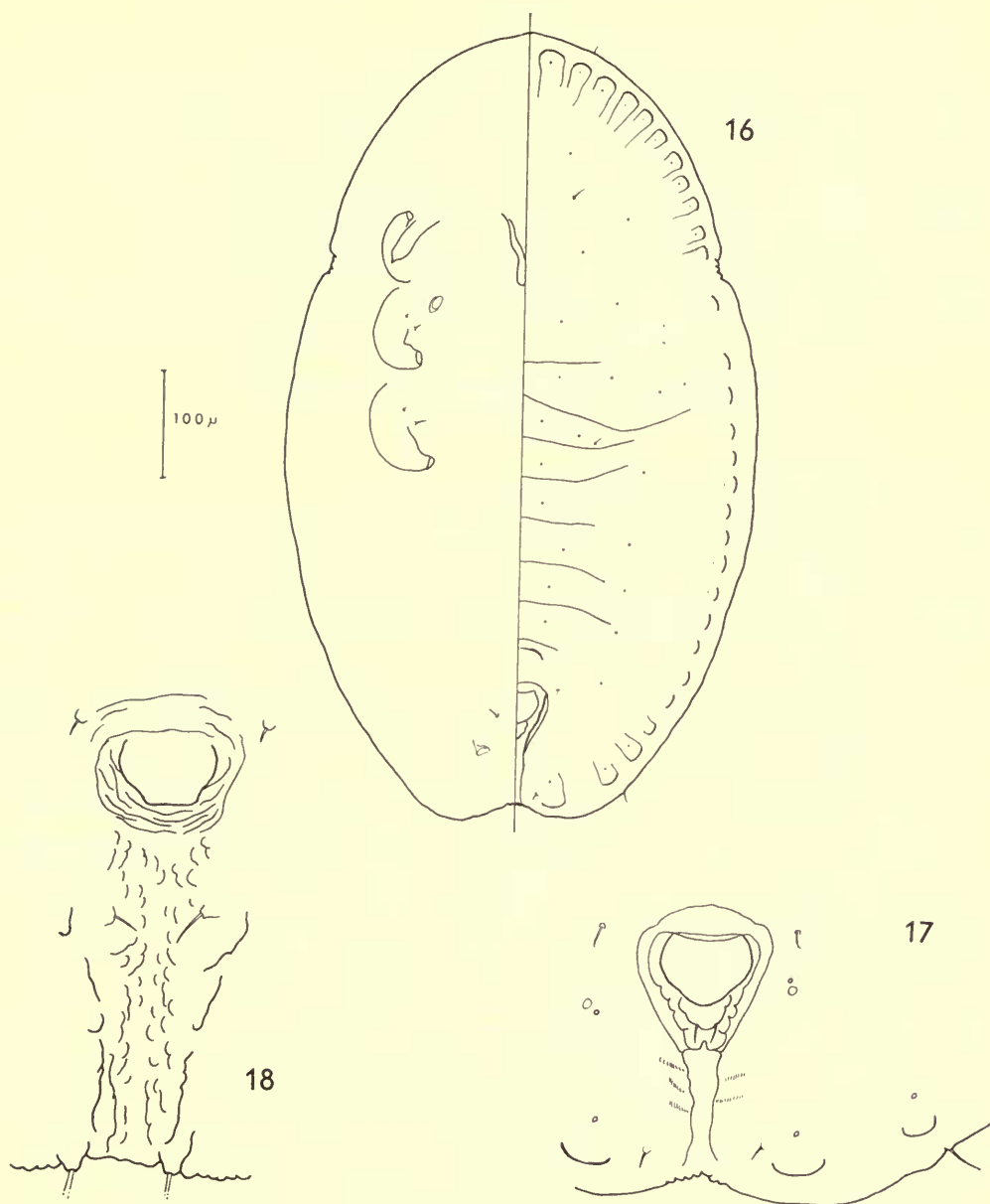
Pupal case. White, with little wax, broadly oval, slightly emarginate at posterior. Length 1.25 mm. Breadth 0.9 mm.

Margin. Finely crenulate, about 20 crenulations in 100 μ . Paired anterior and posterior marginal setae present, 10–30 μ long. Caudal setae on small papillae close to caudal furrow, 15–30 μ .

Dorsal surface. Paired dorsal setae present as follows; cephalic region (15–30 μ long); first abdominal segment, often absent (15–20 μ long); eighth abdominal segment, and posterior to vasiform orifice (10–15 μ long). Submarginal setae (5–15 μ) developed as follows; cephalic region, four pairs; prothorax, one pair; mesothorax, two pairs; metathorax, one pair; abdominal segments one, and four to eight each with one pair, i.e. fourteen pairs. Dorsal surface with numerous small tubercles. Transverse moulting suture extends to subdorsum, ends posterior to its mid-point. Abdominal segments subequal in length in mid-line. Vasiform orifice subcircular, wider than long, 40 $\mu \times$ 55 μ , not cleft at posterior but with several anastomosing lines. Operculum narrowed at posterior, lingula tip barely exposed. Caudal furrow well defined by numerous small tubercles, caudal ridges not large.

Ventral surface. Anterior abdominal spiracles well developed, tracheal folds poorly defined. Ventral abdominal setae 35 μ long, 50 μ apart. Meso- and metathoracic legs each with one small basal seta, 3 μ long. Small paired setae anterior to rostrum, 8 μ long.

Host plants. *Rhododendron* spp.



FIGS. 16-18. 16. *Filicaleyrodes williamsi*, dorsal and ventral surfaces. 17. *F. williamsi*, vasiform orifice. 18. *Dialeurodes chittendeni*, vasiform orifice and caudal furrow.

FILICALEYRODES Takahashi, 1962

Type-species, *F. bosseri* Takahashi, 1962.

This genus was distinguished by Takahashi from *Trialeurodes* by the presence of tracheal pores, a sclerotized ring around the vasiform orifice, the truncated submarginal papillae, and the well developed caudal ridges. In addition to syntypes of *bosseri*, the present author has examined two further species belonging to this group, *T. williamsi* Trehan, and a new undescribed species from Tanganyika taken on ferns. From a study of this material, it is clear that *Filicaleyrodes* is very close to *Trialeurodes*, with which it may prove eventually to be synonymous. The ring around the orifice found in *bosseri* is not so well developed in the other two species referred to above, but all three species differ from *Trialeurodes* in their well developed tracheal pores, and in having submarginal papillae three times as broad as long.

***Filicaleyrodes williamsi* (Trehan) comb. n.**

(Text-figs. 16-17)

Trialeurodes williamsi Trehan, 1938.

According to Trehan, *F. williamsi* was first noticed by C. B. Williams in 1914 on ferns at the Royal Horticultural Society Gardens, Wisley, although the type series came from Kew Gardens in 1937. It is here removed from the genus *Trialeurodes* on account of the well developed tracheal pores and the broad shallow submarginal papillae. The following redescription is based on the holotype and three paratypes in the British Museum (Natural History).

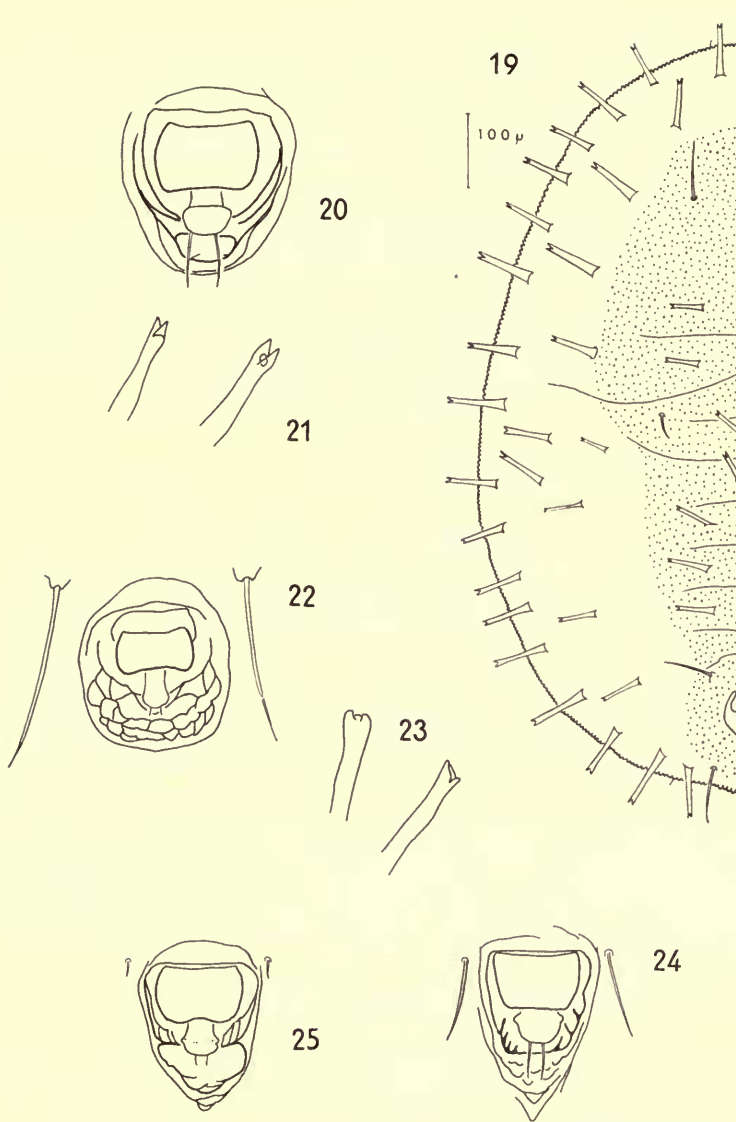
Pupal case. White or lightly shaded with brown. Elliptical, slightly emarginate at posterior. Margin with waxy palisade, also curved wax bands arising from submarginal papillae. Length 0.8 mm. Breadth 0.45 mm.

Margin. Smooth or smoothly crenulate, 20 crenulations in 100 μ . Anterior marginal setae 5 μ long, posterior marginal setae 13 μ long. Caudal setae submarginal in position, 8 μ long. Tracheal pore regions slightly emarginate, with four or five expanded crenulations.

Dorsal surface. Three pairs of small setae (8 μ), on cephalic region, first abdominal segment, and eighth abdominal segment lateral to base of operculum. Two paired rows of segmental pores, on rhachis and on subdorsum. Abdominal segment one with two pairs of pores near rhachis. Submargin with about thirty pairs of broad, shallow papillae (12-20 $\mu \times 5-8 \mu$), with a pore mesad of each papilla. Transverse moulting suture not reaching margin, ends posterior to its mid-point. Second abdominal suture bends sharply to anterior, seventh abdominal segment almost occluded in mid-line due to anterior extension of segment eight. Subdorsal region without papillae, submedian depressions not very evident. Vasiform orifice with expanded anterior rim 10 μ long, lateral margins comparatively thick with about six internal teeth. Posterior border of orifice transverse, notched internally. Internal measurements, 47 μ long, 42 μ wide. Operculum more than half fills orifice exposing half of lingula tip. Lingula tip expanded with a single distal and three paired lateral lobes, terminal paired setae fine, barely extend beyond posterior border of orifice. Caudal furrow well developed, about 15 μ wide at anterior, tapering to 6 μ at posterior, slightly longer than internal length of orifice (50 μ).

Ventral surface. Anterior abdominal spiracles not apparent, posterior spiracles larger than thoracic. Ventral abdominal setae 10 μ long, 35 μ apart. One large (8 μ), and two or more small (3 μ) setae on a band of thickened cuticle around base of both legs on meso and metathorax.

Host plants (after Trehan, 1938). *Oleandra africana*, *Nephrodium confluent*, *Diplazium proliferum*, *Dryopteris flaccida*, *Anemia* sp.



FIGS. 19–25. 19. *Siphoninus immaculata*, dorsal surface. 20. *S. immaculata*, vasiform orifice. 21. *S. immaculata*, tips of dorsal tubes. 22. *S. phillyreae*, vasiform orifice. 23. *S. phillyreae*, tips of dorsal tubes. 24. *Pealius azaleae*, vasiform orifice. 25. *P. quercus*, vasiform orifice.

PEALIUS Quaintance & Baker, 1914

Type-species, *Aleyrodes maskelli* Bemis, 1904.

The species included in this genus can be recognized from the dissected internal surface of the vasiform orifice, the exposed D-shaped tip of the lingula, the presence of a series of small or minute submarginal setae, and the reduction in length of abdominal segment seven. Two species are to be found in England, and they may be separated according to the following key.

Setae on cephalic subdorsum not reaching halfway to body margin; lingula tip wider than long; floor of vasiform orifice with postero-median area lacking sculpture

P. quercus (p. 418)

Cephalic setae longer, often extend beyond body margin; lingula tip at least as long as wide; orifice floor much dissected by ridges

P. azaleae (p. 418)

Pealius azaleae (Baker & Moles)

(Text-fig. 24)

Aleyrodes azaleae Baker & Moles, 1920.

Pealius azaleae (Baker & Moles) Takahashi, 1954.

The Azalea Whitefly is represented in the British Museum (Natural History) collection from Edinburgh; Ringwood, Hampshire, and Wisley, Surrey. At the latter site there has been a continuous population in existence out of doors for over thirty years, and in view of its success there, it is surprising that the species has not established itself elsewhere.

Pupal case. White, with a little wax round margin, elongate elliptical. Length 0.75–0.9 mm. Breadth 0.45–0.55 mm. Tracheal pore areas defined by several slightly thickened marginal crenulations. Anterior and posterior marginal setae present. Dorsum with three pairs of major setae, on cephalic region, and first and eighth abdominal segments, variable in length, 5 μ to 200 μ . Minor setae on abdominal segments four to eight, close to margin, 4 μ long. Similar setae on cephalo-thoracic submargin, but due to minute size (2 μ), these are very difficult to count, apparently five pairs. Transverse moulting suture not reaching margin, second abdominal suture almost as long bending to anterior. Seventh abdominal segment less than half length of segment six. Vasiform orifice elongate cordate, internal surface much dissected, operculum rectangular, D-shaped lingula tip exposed.

Host plant. *Rhododendron mucronatum*, *R. simsii*.

Pealius quercus (Signoret)

(Text-fig. 25)

Aleyrodes quercus Signoret, 1868.

Pealius quercus (Signoret) Trehan, 1940.

Aleyrodes avellanae, Trehan, 1940 nec Signoret, 1868.

Trehan (1940) followed Douglas (1894) in considering a whitefly found on *Corylus avellana*, the adults of which were yellow with immaculate wings, as *A. avellanae* Signoret. However, Signoret states that the adults of *avellanae* have a black spot on the wing and the whole thorax blackish. From this it is evident that two species

were being confused under one name. Fortunately Zahradnik has examined Signoret's type material (see under *Asterobemisia*) and established that Trehan was not correct in considering *avellanae* as a synonym of *quercus*.

P. quercus is widespread and locally abundant in England, and C. B. Williams (1964) has studied a population in Perthshire. The species apparently overwinters in the form of pupal cases on dead leaves lying on the ground, since adults are usually only to be seen during the early part of the summer.

Pupal case. White, with a vertical wax fringe. Broadly oval, slightly constricted at thoracic tracheal pore areas. Length 0.80–0.95 mm. Breadth 0.55–0.70 mm. Thoracic pore areas well defined by series of broad marginal crenulations. Anterior and posterior marginal setae present. Major dorsal setae very small, also caudal setae, less than 10 μ long. Submarginal setae 3 μ long, on abdominal segments four to eight, one pair only observed on cephalic submargin. Transverse moulting suture and second abdominal suture bend to anterior, not reaching margin. Submedian depressions not so well developed as in *azaleae*. Subdorsum with segmental papillae, often indistinct. Seventh abdominal segment less than half length of segment six. Anal apparatus much as in *azaleae* but lingula tip broader than long, orifice floor with median area lacking sculpture.

Host plants. *Quercus* spp., *Corylus avellana*, *Ostrya virginiana*. (*Carpinus*, *Fagus*, *Rubus*—Zahradnik, 1963.)

SIPHONINUS Silvestri, 1915

Type-species, *Siphoninus finitimus* Silvestri, 1915.

This genus is characterized by the numerous short dorsal tubes, each with an open tip, which are found on the pupal case as well as the younger larvae. The adults are apparently distinctive in lacking a paronychium between the tarsal claws. Two species are recorded from Britain, and these may be separated according to the following key.

Dorsal tubes bifurcate at tip; submarginal setae minute, not reaching margin; sculpture of vasiform orifice floor with one large terminal areola *S. immaculata* (p. 420)

Dorsal tubes not bifurcate at tip; submarginal setae extend beyond margin; vasiform orifice floor divided into several large subterminal areolae *S. phillyreae* (p. 419)

Siphoninus phillyreae Halliday, 1834

(Text-figs. 22–23)

The Phillyrea Whitefly is apparently widespread in Southern England, having been reported from Dorset, Surrey and Cambridge. Halliday described it from Dublin. It is found each year on Hawthorn around the British Museum (Natural History). Populations seem to persist in any given locality over long periods of time.

Pupal case. White, with median longitudinal brown stripe. Marginal wax palisade present, also some flocculent dorsal wax. Oval in shape, broadest across first abdominal segment. Length 0.8–1.0 mm. Breadth 0.55–0.70 mm.

Margin. Smooth, crenulations developed only at tracheal pore areas. Posterior marginal setae about 30 μ long, anterior marginal setae very close to mid-line, about 5 μ long.

Dorsal surface. Three pairs of major dorsal setae, 40 μ long, on cephalic region, and first and eighth abdominal segments. Eighth abdominal setae arise anterior to vasiform orifice. Minor dorsal setae, 20–40 μ long, in submargin of abdominal segments one, and four to eight, one pair on each segment; also on metathorax, one pair; mesothorax, two pairs; prothorax, one pair; cephalic region, four pairs. Dorsal tubes about 100 μ long, variable in total number 55 to 75, in three paired rows; submarginally about 14 pairs, subdorsally about 14 pairs, medially about five pairs with a single tube on second abdominal segment. Apex of these tubes cup-shaped, not distinctly bifid. Transverse moulting suture almost reaches margin, second abdominal suture bends to anterior. Seventh abdominal segment two-thirds as long as segment six. Vasiform orifice rounded posteriorly, little longer than broad, 52 $\mu \times$ 48 μ , posterior half of internal surface with two or more large areolae. Operculum occupies less than half of orifice, lingula tip little expanded, reaching to middle of orifice, without long terminal setae. Caudal furrow not developed, caudal setae submarginal in origin.

Ventral surface. Tracheal folds not developed, posterior abdominal spiracles larger than anterior pair. Ventral abdominal setae 25 μ long, 50 μ apart. Meso- and metathoracic legs each with one seta at base, 3 μ long. Antennae reach to first spiracle.

Host plants. *Phillyrea latifolia*, *Crataegus oxyacantha*, *Pyrus communis*.

Siphoninus immaculata Heeger, 1855

(Text-figs. 19–21)

This species is apparently quite specific to Ivy (*Hedera helix*), on which it is widespread but infrequent throughout Southern England.

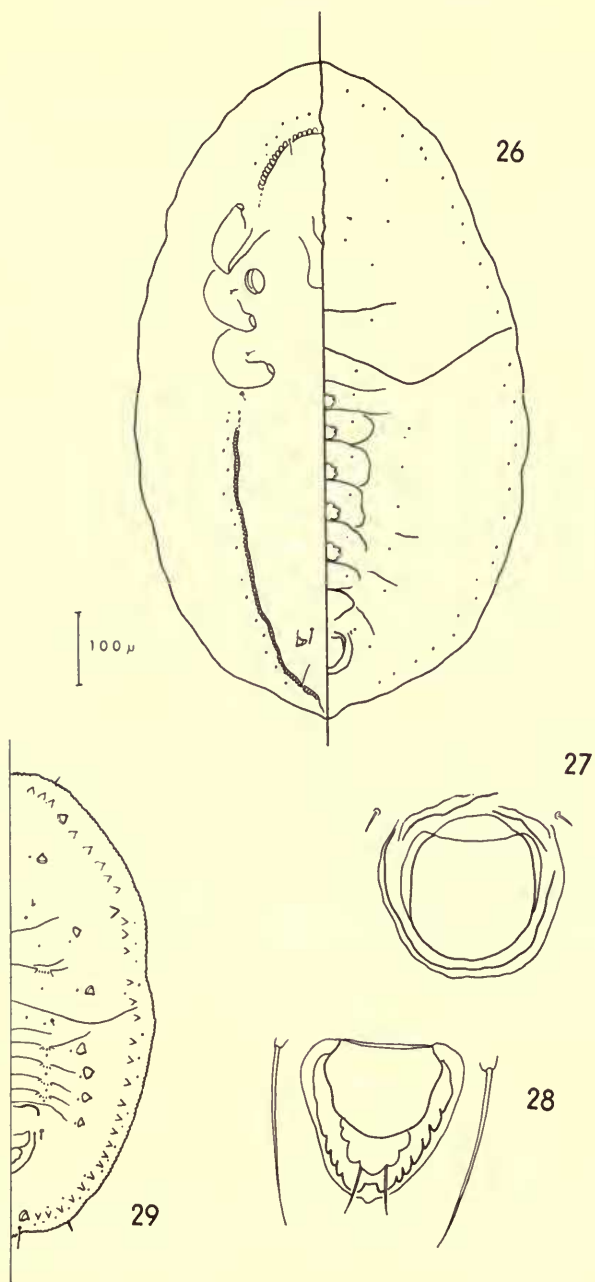
Pupal case. As in *phillyreae* except as follows; without dorsal wax, minor dorsal setae very small, 3 μ , not reaching margin. Dorsal tubes clearly bifid at apex. Vasiform orifice longer than broad, 75 $\mu \times$ 65 μ , with one large areola distally, operculum occupies half of orifice, lingula tip expanded with two long setae extending beyond margin of orifice.

TETRALICIA Harrison, 1917

Type-species, *T. ericae* Harrison, 1917.

Tetralicia was based originally upon a description of adult whitefly collected on *Erica tetralix* at Walldridge Fell, Durham. The first definition of the genus is to be found in a key to the genera of Aleyrodidae by Baker & Moles (1923). The most important character is the way in which the dorsal surface of the pupal case is deflexed ventrally to meet the reduced ventral surface. In view of the close similarity between this genus and *Aleuropleurocelus* Drews & Sampson, 1956, the following details are given which may be of generic importance.

Pupal case. Elongate ovate. Dorsal surface larger than ventral, reflexed ventrally, true margin ventral in position, smoothly crenulate with pores. Anterior and posterior marginal setae present, rather long, about as long as caudal setae. Transverse moulting suture reaches apparent margin. Cephalic and eighth abdominal setae small or minute, first abdominal segment apparently lacks setae. Rhachis with median tubercles. Vasiform orifice subcordate, inner lateral margins ridged, operculum fills orifice, concealing lingula. Anterior abdominal spiracles smaller than posterior. Meso- and metathoracic legs each with one basal seta.



FIGS. 26-29. 26. *Tetralicia ericae*, dorsal and ventral surfaces. 27. *T. ericae*, vasiform orifice. 28. *Trialeurodes vaporariorum*, vasiform orifice. 29. *T. vaporariorum*, dorsal surface.

Tetralicia ericae Harrison, 1917

(Text-figs. 26-27)

In the original description of this species the larva was referred to as "transparent whitish", but Trehan has pointed out that this was probably based on a newly moulted specimen. The following redescription is based on black pupal cases, subsequently bleached, which were determined as belonging to this species by the original author in 1929, and deposited at the British Museum (Natural History) by E. E. Green. *T. ericae* has been found throughout England from Northumberland to the South Coast, but although locally common it is not frequent.

Pupal case. Black, margin with fringe of white wax. Elongate oval to elliptical, orientated along length of leaf, often concealed by curled leaf margins. Length 0.95-1.05 mm. Breadth 0.50-0.55 mm.

Margin. Deflexed ventrally except at caudal extremity, smooth, with well developed wax pores. Anterior and posterior marginal setae present, about 40 μ long. Caudal extremity rather protruding, bearing caudal setae, about 40 μ long. Tracheal pore areas not developed.

Dorsal surface. Setae apparently absent from first abdominal segment. Paired setae on cephalic region, and eighth abdominal segment anterior to orifice, 5 μ long. Longitudinal moulting suture reaches true margin, transverse moulting suture reaches apparent margin. Cephalic and prothoracic sutures poorly developed. First abdominal suture approaches transverse moulting suture, second suture bends to anterior in subdorsum. Remaining abdominal sutures not visible on subdorsum. Rhachis with well developed median tubercles on segments two to six. Segment seven three-fifths, segment six four-fifths of segment eight. Pores in four paired rows, on rhachis, subdorsally near rhachis, subdorsally near apparent margin, submarginally on ventral reflexed part of dorsal surface. Vasiform orifice broadly subcordate, margin broad, internal surface ridged, giving appearance of teeth laterally, internal measurements 52 $\mu \times 52 \mu$. Operculum fills orifice, posterior border rectangular, conceals lingula (cf. Trehan, 1940, and Drews & Sampson, 1956, in which the figure is of a specimen damaged with caustic potash during bleaching, under which treatment the operculum often collapses laterally). Caudal ridges and furrow not developed.

Ventral surface. Anterior abdominal spiracles smaller than posterior. Ventral abdominal setae long, 40 μ , about 65 μ apart at base. Meso- and metathoracic legs each with one fine seta. 5 μ long, on small tubercle. One pair of small setae, 3 μ long, anterior to rostrum. Antennae reach base of prothoracic legs. Ventral adhesive organ heavily sclerotized.

Host plant. *Erica* species.

TRIALEURODES Cockerell, 1902

Type-species, *Aleurodes pergandei* Quaintance, 1900.

As a result of the work of Russell (1948) on the North American species, the range of variation and the characters which should be studied in this group are well understood. Within any one species, the range of development of the submarginal and subdorsal papillae, which in life bear long wax filaments, is very great, and this variation is associated with the degree of hairiness of the host plant leaf. The appearance of the vasiform orifice and the trilobed lingula is quite distinctive of this genus and the related *Filicaleyrodes*.

Trialeurodes vaporariorum (Westwood)

(Text-figs. 28-29)

Aleurodes vaporariorum Westwood, 1856.*Asterochiton vaporariorum* (Westwood) Quaintance & Baker, 1914.*Trialeurodes vaporariorum* (Westwood) Russell, 1948.*Trialeurodes sonchi* (Kotinsky, 1907) [Syn. Russell, 1948].

Although the Greenhouse Whitefly was first described from this country, it was certainly introduced from some warmer climate. It can be found out of doors during the summer, but in winter it is probably restricted to glasshouses. The range of hosts is very large (Russell, 1963) and consequently so is the range of morphological variation (Hussey & Gurney, 1957).

In view of the detailed description given by Russell (1948), only the more important characters are given below. This redescription is based in part on a series of specimens loaned to the author from Westwood's Economic Collection at the Hope Department, Oxford, by courtesy of Professor Varley. The two leaves bearing pupal cases which are pinned in that collection, do not appear to belong to any of the plant species which Westwood named in his original description of the Greenhouse Whitefly. In view of this it has been decided not to designate a lectotype from this material. The specimens, however, are of considerable importance as they were collected before the introduction of the so-called American Race, the females of which produce males parthenogenetically, whereas the British Race produced only females (Schrader, 1926).

Pupal case. White, broadly oval, with vertical wax palisade, and numerous marginal wax filaments. Wax filaments sometimes lie horizontally, sometimes stand almost erect. Very lightly sclerotized, margin weakly crenulate. Tracheal pore areas usually indicated. Anterior and posterior marginal setae present, caudal setae submarginal in origin. Marginal papillae highly variable; on specimens from smooth leaf, papillae almost equal in size; on specimens from hairy leaf, several papillae frequently enlarged, such pupal cases also have several pairs of dorsal papillae. Submarginal pores closer to margin than submarginal papillae. Small dorsal setae on cephalic region, and first and eighth abdominal segments, the latter occasionally longer than the orifice. Seventh abdominal segment short but still visible in mid-line. Vasiform orifice subcordate, without anterior rim, notched at posterior. Operculum cordate, covering only proximal pair of lingula lobes. Meso- and metathoracic leg bases slightly sclerotized, each bearing one or more small setae. Anterior abdominal spiracles present.

[illegible]

REFERENCES

(* not seen by author)

- *ASHMEAD, W. H. 1885. *Florida Dispatch*. ns. **11**. (ex Quaintance & Baker, 1917).
- BAERENSprung, F. 1849. Beobachtungen über einige einheimische Arten aus der Familie der Coccinen. *Ztg. Zool.* **1**: 165-170.
- BAKER, A. C. & MOLES, M. L. 1920. A new species of Aleyrodidae found on azalea (Hom.). *Proc. ent. Soc. Wash.* **22**: 81-83.
- 1923. The Aleyrodidae of South America with descriptions of four new Chilean species. *Revta chil. Hist. nat.* **25**: 609-656.
- BECK, B. D. A. & CHANT, S. R. 1958. A preliminary investigation on the effect of mosaic virus on *Manihot utilissima* Pohl. in Nigeria. *Trop. Agric. Trin.* **35**: 59-64.
- BEMIS, F. E. 1904. The Aleyrodids or mealy-winged flies of California, with reference to other American species. *Proc. U.S. natn. Mus.* **27**: 471-537.
- COCKERELL, T. D. A. 1902. Classification of Aleyrodidae. *Proc. Acad. nat. Sci. Philad.* **54**: 279-283.
- DANZIG, E. M. 1964. Contribution of the knowledge of the White-flies (Homoptera, Aleyrodidae) of the Caucasus. [In Russian] *Ént. Obozr.* **43**: 633-646.
- DOUGLAS, J. W. 1888. Description of a new species of *Aleurodes*. *Entomologist's mon. Mag.* **24**: 265-267.
- 1891a. On a Brazilian species of *Aleurodes* found in England. *Entomologist's mon. Mag.* **27**: 44.
- 1891b. A new species of *Aleurodes*. *Entomologist's mon. Mag.* **27**: 200, 322-323.
- 1894. A new species of *Aleurodes*. *Entomologist's mon. Mag.* **30**: 73-74.
- DREWS, E. A. & SAMPSON, W. W. 1956. *Tetralicia* and a new related genus, *Aleuropleurocelus* (Homoptera, Aleyrodidae). *Ann. ent. Soc. Am.* **49**: 280-283.
- FOWLER, V. W. 1954. Notes on some pests observed in the course of advisory work at Wisley, during 1953. *Jl R. hort. Soc.* **89**: 405.
- FRAUENFELD, G. R. VON. 1867. Ueber *Aleurodes* und *Thrips*, vorzüglich in Warmhause. *Verh. zool.-bot. Ges. Wien* **17**: 793-801.
- GENNADIUS, P. 1889. Disease of tobacco plantations in the Trikonía. The Aleurodid of Tobacco. [In Greek.] *Ellenike Georgia* **5**: 1-3.
- GEOFFROY, E. L. 1762. *Histoire abrégée des Insectes qui se trouvent aux environs de Paris*. Paris.
- 1785. In Fourcroy, A. L. *Entomologia Parisiensis*. Paris.
- GOELDI, E. 1886. Beiträge zur Kenntniss der kleinen und kleinsten Gliederthierwelt Brasiliens. *Mitt. schweiz. ent. Ges.* **7**: 231-255.
- GOMEZ-MENOR, J. 1943. Contribucion al conocimiento de los Aleyrodidos de España (Hemiptera, Homoptera). *Eos, Madr.* **19**: 173-209.
- HALIDAY, A. H. 1835. *Aleyrodes phillyreae*. *Entom. Mag.* **2**: 119-120.
- HARRISON, J. W. H. 1917. A new species and genus of Aleyrodidae from Durham. *Vasculum* **3**: 60-62.
- 1920. New and rare British Aleurodidae. *Entomologist* **53**: 255-257.
- HAUPT, H. 1935. Aleurodina, in *Die Tierwelt Mitteleuropas*. Hemiptera **4**: 253-260. Leipzig.
- HEEGER, E. 1855. Beiträge zur Naturgeschichte der Insecten. Naturgeschichte der *Aleurodes immaculata* Steph. *Sber. Akad. Wiss. Wien. math. nat.* **18**: 33-36.
- HUSSEY, N. W. & GURNEY, B. 1957. *Trialeurodes sonchi* Kotinsky, a synonym of *Trialeurodes vaporariorum* Westwood (Hemiptera, Homoptera). *Entomologist's mon. Mag.* **93**: 254.
- KLOET, G. S. & HINKS, W. D. 1964. A check list of British Insects. Pt. 1 (revised) *Handbk Ident. Br. Insects* **11**.
- KOCH, C. L. 1857. *Die Pflanzenläuse Aphiden*. 324-328. Nürnberg.
- KOTINSKY, J. 1907. Aleyrodidae of Hawaii and Fiji with descriptions of new species. *Bull. Bd Commrs Agric. For. Hawaii Div. Ent.* **2**: 93-102.

- KÜNOW, G. 1880. Zwei neue Schildläuse. *Ent. Nachr.* **6** : 46.
- LAING, F. 1928. Description of a new whitefly pest of Rhododendrons. *Entomologist's mon. Mag.* **64** : 228-230.
- LATREILLE, P. A. 1795. *Magasin Encycl.* **4** : 304-310.
- 1796. *Précis des caractères génériques des Insectes, disposés dans un ordre naturel.* Paris.
- 1801-2. *Histoire naturelle des Crustacés et des Insectes.* Paris.
- 1807. *Genera Crustaceorum et Insectorum.* Paris.
- MOUND, L. A. 1961. A new genus and four new species of whitefly from ferns (Homoptera, Aleyrodidae). *Revue Zool. Bot. afr.* **44** : 127-132.
- 1962. *Aleurotrachelus jelinekii* (Frauen.) (Homoptera, Aleyrodidae), in Southern England. *Entomologist's mon. Mag.* **97** : 196-197.
- 1963. Host correlated variation in *Bemisia tabaci* (Gennadius) (Homoptera, Aleyrodidae). *Proc. R. ent. Soc. Lond. (A)* **38** : 171-180.
- 1965a. Effect of leaf hair on cotton whitefly populations in the Sudan Gezira. *Emp. Cott. Grow. Rev.* **42** : 33-40.
- 1965b. An introduction to the Aleyrodidae of Western Africa. *Bull. Br. Mus. (nat. Hist.), Ent.* **17** (3) : 113-160.
- 1965c. The effect of whitefly (*Bemisia tabaci*) on cotton in the Sudan Gezira. *Emp. Cott. Grow. Rev.* **42** : 290-294.
- NEWSTEAD, R. 1911. On a collection of Coccidae and Aleurodidae, chiefly African, in the collection of the Berlin Zoological Museum. *Mitt. zool. Mus. Berl.* **5** : 155-174.
- OSSIANNILSSON, F. 1955. Till kännedomen om de svensta mjollössen (Hemiptera, Homoptera, Aleyrodina). *Opusc. ent.* **20** : 192-199.
- QUAINTANCE, A. L. 1900. Contributions toward a monograph of the American Aleyrodidae. *Tech. Ser. Bur. Ent. U.S.* **8** : 1-48.
- QUAINTANCE, A. L. & BAKER, A. C. 1913 & 1914. Classification of the Aleyrodidae. *Tech. Ser. Bur. Ent. U.S.* **27** (I) : 1-93 ; **27** (II) : 95-114.
- REAMUR, R. A. F. 1736. *Mémoires pour servir à l'histoire des Insectes.* Paris.
- RUSSELL, L. M. 1948. The North American species of Whiteflies of the genus *Trialeurodes*. *Misc. Publs U.S. Dep. Agric.* **635** : 85 pp.
- 1958. Synonyms of *Bemisia tabaci* (Gennadius) (Homoptera, Aleyrodidae). *Bull. Brooklyn ent. Soc.* **52** : 122-123.
- 1963. Hosts and distributions of five species of *Trialeurodes* (Homoptera, Aleyrodidae). *Ann. ent. Soc. Am.* **56** : 149-153.
- SCHRADER, F. 1926. Notes on the English and American races of the Greenhouse whitefly (*Trialeurodes vaporariorum*). *Ann. appl. Biol.* **13** : 189-196.
- SCHUMACHER, F. 1918. Mottenläuse. Verzeichnis der Aleyrodiden Europas. *Dt. ent. Z.* **1918** : 404-406.
- SILVESTRI, F. 1915. Contributo alla conoscenza degli insetti dell'olivo dell'Eritrea e dell'Africa meridionale. *Boll. Lab. Zool. gen. agr. R. Scuola Agric. Portici.* **9** : 245-249.
- STEARNS, W. T. 1957. Introduction to facsimile edition of Linnaeus' Species Plantarum, 1753. Vol. I. Royal Society, London.
- TAKAHASHI, R. 1938. Notes on Aleyrodidae of Japan (Homoptera). *Kontyû* **12** : 70-74.
- 1954. Key to the Tribes and Genera of Aleyrodidae of Japan, with descriptions of three new genera and one new species. *Insecta Matsum.* **18** : 47-53.
- 1962. Two new genera and species of Aleyrodidae from Madagascar (Homoptera). *Proc. R. ent. Soc. Lond. (B)* **31** : 100-102.
- TARR, S. A. J. 1951. *Leaf curl disease of cotton.* Commonw. Mycol. Inst. London. 55 pp.
- TREHAN, K. N. 1938. Two new species of Aleyrodidae found in greenhouses in Britain (Hemiptera). *Proc. R. ent. Soc. Lond. (B)* **7** : 182-189.
- 1940. Studies on the British Whitefly (Homoptera). *Trans. R. ent. Soc. Lond.* **90** : 575-616.
- TULLGREN, A. 1907. Über einige Arten der Familie Aleurodidae. *Ark. Zool.* **3** (26) : 1-18.

- VALLISNERI, A. 1733. Opere fisico mediche continenti un gran numero di trattati, &c. **1**. Venezia.
- WALKER, F. 1852. *List of the specimens of Homopterous Insects in the collection of the British Museum*. Part 4: 1091-1093. London.
- WESTWOOD, J. 1840. *Introduction to the modern Classification of Insects*. London.
- 1856. The *Aleyrodes* of the Greenhouse. *Gdnrs' Chron.* **1856**: 852.
- WILLIAMS, C. B. 1964. *Patterns in the balance of nature*. 324 pp. Academic Press, London and New York.
- ZAHRADNIK, J. 1961. La redescription d'*Asterobemisia avellanae* (Signoret, 1868) (Homoptera, Aleyrodinea). *Sb. ent. Odd. nár. Mus. Praze* **34** (593): 433-438.
- 1963. Aleyrodina, *In Die Tierwelt Mitteleuropas*. **4**. 10d. 19 pp. Leipzig.

INDEX TO GENERA AND SPECIES

Synonyms in italics

- | | |
|------------------------------|-------------------------------|
| acerina, 407 | Dialeurodes, 401, 403, 414 |
| <i>aceris</i> , 400, 407-8 | <i>douglasi</i> , 408 |
| <i>aceris ovatus</i> , 407-8 | |
| <i>acerum</i> , 408 | ericae, 400-1, 420, 422 |
| Aleurocanthus, 401 | |
| Aleurochiton, 403, 407-8 | Filicaleyrodes, 402, 416 |
| Aleuroclava, 414 | filicicola, 401, 408 |
| Aleurocybotus, 400 | <i>filicum</i> , 408, 410 |
| Aleurodicus, 401 | finitimus, 419 |
| Aleurolobus, 401 | flocossus, 401 |
| Aleuroplatus, 408, 410 | fragariae, 401, 404, 406 |
| Aleuropleurocelus, 420 | <i>Frauenfeldiella</i> , 410. |
| Aleuropteridis, 403, 408 | |
| Aleurothrixus, 401 | immaculata, 400-1, 419, 420 |
| Aleurotrachelus, 402, 410 | <i>inconspicua</i> , 413 |
| Aleurotulus, 402, 410 | |
| Aleyrodes, 403 | jelinekii, 400-1, 410 |
| Asterobemisia, 402, 411 | |
| Asterochiton, 411, 423 | <i>kewensis</i> , 408, 410 |
| avellanae, 400-1, 411-3, 418 | |
| azaleae, 400-1, 418 | <i>lonicerae</i> , 406 |
| | |
| barodensis, 401 | malayensis, 414 |
| Bemisia, 400, 402, 413-4 | maskelli, 418 |
| bergii, 401 | minima, 413 |
| bicolor, 414 | miniscula, 413 |
| bosseri, 416 | |
| <i>brassicae</i> , 404 | Neoaleurochiton, 407 |
| | Neomaskellia, 401 |
| <i>carpini</i> , 400, 411 | nephrolepidis, 408, 410 |
| <i>chelidonii</i> , 404 | |
| Chermes, 407-8 | Pealius, 402, 418 |
| chittendeni, 400-1, 414 | pergandei, 422 |
| citri, 401, 414 | Phalaena, 403-4 |
| cocois, 401 | phillyreae, 400-1, 419 |
| complanatus, 401, 407-8 | proletella, 401, 403-4 |
| <i>culiciformis</i> , 404 | pseudoplatani, 407 |

quercus, 401, 418

ribium, 411, 413

rubicola, 411, 413

Siphoninus, 402, 419

sonchi, 423

spiracae, 406

tabaci, 400-1, 413

Tetralicia, 402, 420

Tinea, 403

tracheifer, 410

Trialeurodes, 400, 402, 422

vaccinii, 400, 411

vaporariorum, 400-1, 423

williamsi, 401, 416

woglumi, 401

